



RESEARCH ARTICLE

Anonymised and aggregated crowd level mobility data from mobile phones suggests that initial compliance with COVID-19 social distancing interventions was high and geographically consistent across the UK [version 1; peer review: 2 approved]

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Abstract

Background: Since early March 2020, the COVID-19 epidemic across the United Kingdom has led to a range of social distancing policies, which have resulted in reduced mobility across different regions. Crowd level data on mobile phone usage can be used as a proxy for actual population mobility patterns and provide a way of quantifying the impact of social distancing measures on changes in mobility.

Methods: Here, we use two mobile phone-based datasets (anonymised and aggregated crowd level data from O2 and from the Facebook app on mobile phones) to assess changes in average mobility, both overall and broken down into high and low population density areas, and changes in the distribution of journey lengths.

Results: We show that there was a substantial overall reduction in mobility, with the most rapid decline on the 24th March 2020, the day after the Prime Minister's announcement of an enforced lockdown.

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report



report

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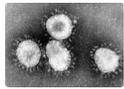
The reduction in mobility was highly synchronized across the UK. Although mobility has remained low since 26th March 2020, we detect a gradual increase since that time. We also show that the two different datasets produce similar trends, albeit with some location-specific differences. We see slightly larger reductions in average mobility in high-density areas than in low-density areas, with greater variation in mobility in the high-density areas: some high-density areas eliminated almost all mobility.

Conclusions: These analyses form a baseline from which to observe changes in behaviour in the UK as social distancing is eased and inform policy towards the future control of SARS-CoV-2 in the UK.

Keywords

Covid-19, SARS-CoV-2, Mobility, Mobile Phone, United Kingdom

Any reports and responses or comments on the article can be found at the end of the article.



This article is included in the [Coronavirus \(COVID-19\)](#) collection.

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Introduction

Previous studies have highlighted the impact of changes in human mobility on the transmission dynamics of SARS-CoV-2 in China^{1,2}, Italy³, Brazil⁴, and elsewhere. To slow the spread of SARS-CoV-2, many countries have imposed social distancing interventions designed to reduce the number of potentially infectious contacts. These interventions also reduce individual mobility. Therefore, monitoring both national and local changes in mobility can provide useful measures of intervention efficacy, especially in the early stages of national epidemics⁵.

Human mobility data gathered from mobile phone handsets have been used effectively to measure population response to health crises prior to the emergence of the SARS-CoV-2^{6,7}. The high numbers of mobile phone users worldwide make mobile phone data a good proxy for population mobility patterns⁸. The anonymised and aggregated crowd level location data used from O2 is based on the location of the cell site mast to which devices are near at a point in time⁸. This is distinct from other companies which are predominantly app based social media and search companies providing location data via the phone operating system and their apps which record the location and estimated accuracy of that location at regular intervals when GPS is enabled on the handset.

The UK government introduced social distancing via a series of specific policies: from 12th March, individuals displaying any COVID-19 symptoms – either a new continuous cough or a high temperature – were asked to isolate at home for 7 days. From 16th March, people were asked to stop all non-essential contact, stop all unnecessary travel, and to work from home where possible. The recommendation of self-isolation for those with symptoms continued, but, in addition, from that time non-symptomatic members of the household were also asked to isolate for 14 days. Schools were closed after 20th March, along with pubs, clubs, restaurants, gyms, and other retail and leisure locations. From 23rd March, government guidance changed further to “you must stay at home”, with people only being allowed to leave their home for essential food shopping, medical necessity, one daily form of exercise, and work if working from home was not possible. The first relaxation of these measures occurred in England on the evening of 10th May 2020 when individuals who could not work from home were encouraged to return to work on 11th May. From 13th May all individuals in England were permitted to engage in multiple trips outdoors for exercise or to visit parks. (See *Extended data*, Table S1⁹, which includes links to specific pages on www.gov.uk for each non-pharmaceutical intervention.)

Here we use data from the Facebook application on mobile phones (referred to as Facebook app in the rest of this document) from the COVID Mobility Data Network for the United Kingdom (UK) and Ireland, and mobile phone data from O2, which is not only anonymised and aggregated to crowd level data but which is also further extrapolated to give a picture of the full UK population, to describe recent changes in mobility across the UK and potential implications for SARS-CoV-2 transmission.

Methods

Data sources

We received data via the Facebook Data for Good program¹⁰ describing the daily number of trips starting within a tile, and the sum of the length of all trips starting within a tile, where a tile is defined by a grid that Facebook applies to the Earth’s surface in order to aggregate the movement of its users¹¹. Each tile is approximately 25 km². A trip in the Facebook data is defined as the movement of a handset from one tile to another between two subsequent updates of the geolocation data (the time period between updates is defined by mobile phone operating systems). The latitude and longitude of the centroid of each tile was provided and these were used to aggregate data from the tile level to the local authority district (LAD) level for consistency with the mobile network data (described below). The data were used for 10th March - 22nd May 2020 inclusive for Facebook and for 1st February - 5th May 2020 inclusive for the mobile network.

Facebook also provided data on the daily number of active users of their app, with GPS location services enabled, within different locations. We also aggregated these data to UK LADs and calculated the Facebook population size in each LAD relative to the mean in the first week of data (10th - 16th March 2020 inclusive). To adjust for changing Facebook population size over time (*Extended data*, Figure S2⁹) the number of daily trips per LAD and the daily total distance travelled per LAD were divided by the Facebook population size per LAD relative to the first week of data.

In addition to the Facebook data, we received anonymised and aggregated crowd level mast data from O2 (which is further modelled to the UK population) detailing the number of trips starting within each UK local authority district for 1st February - 5th May 2020 inclusive. A trip is created when a device moves from one overlapping group of cells to another (where a cell is an area of coverage provided by a single mobile network antenna) and remains with the group of cells for long enough to indicate the device is stationary. As these are mast data, all mobile phones registered to the data provider’s network are recorded, not just smartphones with GPS tracking enabled.

Data comparison and normalisation

To enable comparison of the mobile network data with the Facebook data, we defined a baseline level of mobility as the mean daily number of trips within the week 10th - 16th March 2020 per LAD. We then calculated the percentage change in mobility for the Facebook and mobile network data compared to this baseline.

We inspected the data on mean daily number of trips within the following spatial regions: individual countries of the UK, specific cities (defined by the boundaries of their constituent LADS) which were selected because they are the largest city in each of the four countries of the UK respectively (London, Cardiff, Glasgow, and Belfast), LADs, and finally we grouped the LADs into quartiles of population density (throughout, the quartile of lowest population density is

referred to as 1, whilst quartile 4 is the quartile of greatest population density). The location of population density quartiles is shown in *Extended data*, Figure S1⁹. Data describing the population per LAD were provided by LandScan¹².

Model fitting

We fitted a segmented-linear model¹³ to the percentage relative to baseline for the nationally aggregated Facebook data against time. The segmented-linear model divides the data into multiple time components split by “breakpoints”, then, using linear regression fits a straight line to each separate component. The dates of each breakpoint are included as parameters of the model. The minimum size of a component allowed was chosen to be three data points to minimise overfitting.

Due to the categorical difference between levels of mobility on weekdays, Saturdays, and Sundays, we only fitted the model to weekdays. Bank holidays were also omitted from the data during the fitting as they were markedly different to the other weekdays but were not considered to be representative of any longer-term trends in the data.

We investigated segmented-linear models with 0, 1, 2, 3, 4, 5 and 6 breakpoints. For each model, all possible permutations of breakpoints were considered subject to the constraint of there being a minimum of three data points per component. For each permutation the other parameters of the model were fitted assuming log-normal errors for the number of trips as a percentage compared to baseline. The relative weighting of points was estimated using inverse-variance weighting, where relative variance was estimated as the daily number of trips. The permutation with the highest likelihood was then considered the best fit for the model. Comparisons of the segmented-linear models (with different numbers of breakpoints) were made using the corrected Akaike information criterion (AICc), with the most parsimonious model being the one with the lowest AICc.

Finally, we also investigated differences in the distribution of distance travelled per journey in areas of high and low population density, and how these distributions changed following the introduction of social distancing measures. The shape of these distributions was defined by smoothing over the data points using a Gaussian kernel.

All the analysis was conducted using the R statistical programming language¹⁴; the code used to plot the figures and run the analyses is publicly available at <https://github.com/mrc-ide/covid-uk-mobility-report> and has been archived with Zenodo⁹.

Results

Changes in mobility over time

The mean number of trips per local authority district (LAD) made in the UK by users of the Facebook mobile phone app dropped substantially between the 18th and 26th of March inclusive (Figure 1), from around 99% of the baseline to around

37%. The number of trips was still close to the baseline on Friday 20th March (the last day in which schools were open, other than to vulnerable children and the children of key workers, see *Extended data*, Table S1⁹) at approximately 87% of the baseline, then dropped substantially over the weekend of 21st - 22nd March to about 30% of the baseline number of daily trips per LAD. This was the first weekend during which all pubs, clubs, bars, gyms, etc. were closed (*Extended data*, Table S1⁹). We see a slight increase in the mean number of trips per LAD on Monday 23rd to 67% of the baseline. On the evening of Monday 23rd of March the government messaging changed from “we advise you to stay home” to “you must stay home”. From Tuesday 24th to Thursday 26th of March we then see a greater decrease in the number of daily journeys made per LAD to approximately 40% of the baseline across the UK on working days, and approximately 15% of the baseline on the following weekend. As a percentage of the number of daily trips made per LAD, this difference between weekdays and weekends remains approximately constant from the 26th of March until the last day of data we considered: the 22nd of May (Figure 2 and Figure 3).

Mobility variation by location and data source

There was little variation in mobility reductions either by data source, city (London, Cardiff, Glasgow, Belfast), or country of the UK (Figure 2). There were clear weekend effects in all areas (see the previous paragraph) and small variations from day to day (Figure 2); however, trends across different locations were highly consistent. For example, on the Wednesday of the first full week post-lockdown (the 31st of March 2020) the city with the greatest number of daily trips relative to the baseline was Belfast according to the Facebook data and Glasgow according to the mobile phone data (30% and 35% of the baseline respectively), and the city with the fewest number of daily trips relative to the baseline on the same day were Glasgow according to the Facebook data and Belfast according to the mobile phone data (29% and 33% of the baseline, respectively). On average, the Facebook data suggested fewer trips were made following the social distancing interventions than the mobile phone data.

Following the initial reduction in mobility coinciding with the introduction of social distancing measures, there has been a gradual increase in the number of daily trips made by Facebook and mobile phone users, starting on approximately the 1st of April and continuing until the 22nd of May (Figure 2–Figure 4). Using the Facebook data, we fitted multiple segmented-linear models (see *Methods*) to the number of daily journeys made per LAD as a percentage relative to the baseline (mean number of daily trips per tile in the week 10th – 16th of March). A segmented-linear model with five breakpoints was the most parsimonious (Figure 3) with breakpoints on 13th March, 23rd March, 27th March, 20th April, and 27th April. However, a four-breakpoint model had only a marginally higher AICc (-300.68 vs -299.86) and so could not be rejected (*Extended data*, Table S2⁹). For the period between the 27th March and 20th April there has been a statistically significant increase in the number of daily trips (p-value < 0.001),

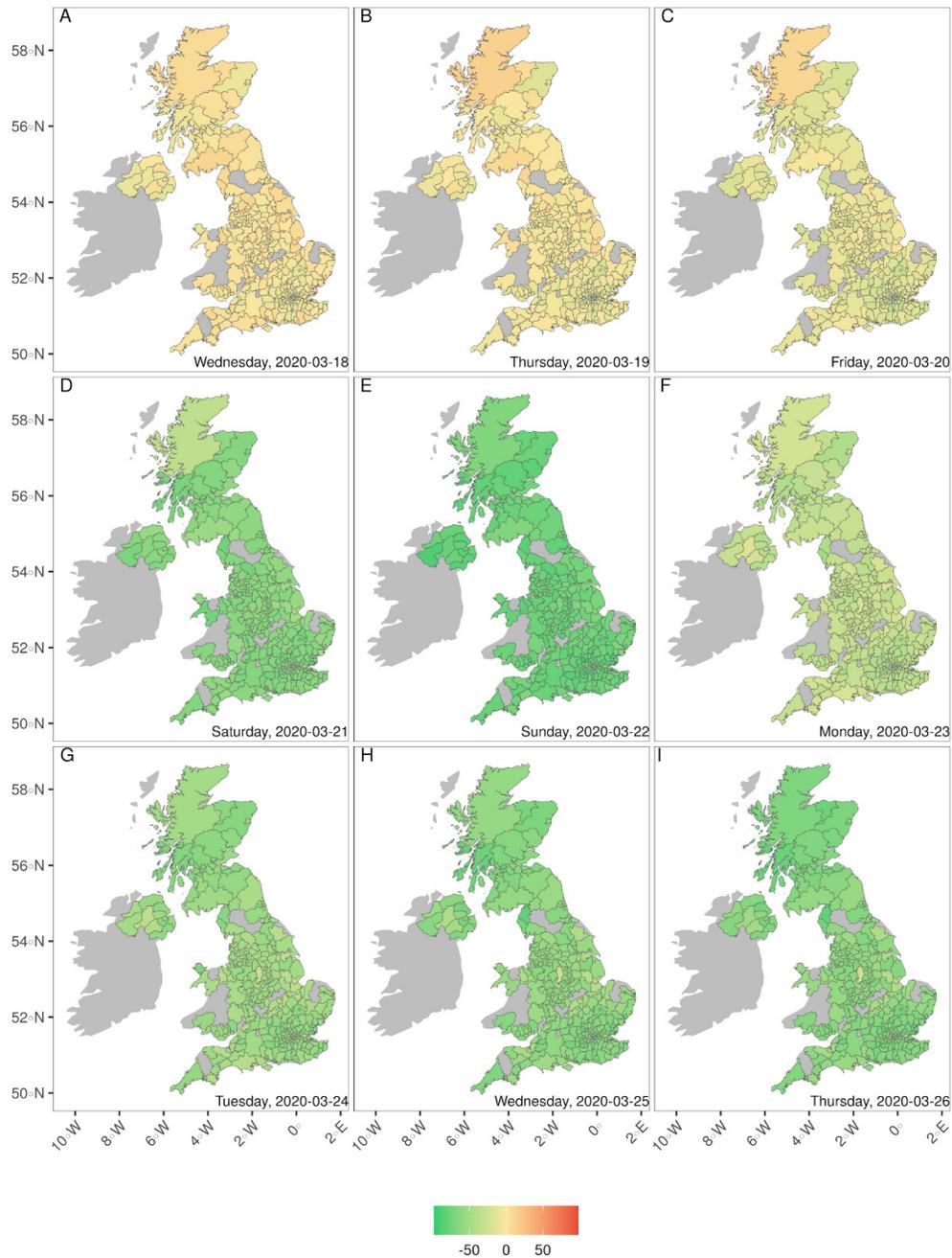


Figure 1. Rapid reduction in mobility in the UK from the 18th March 2020 (A) through to the 26th March (I). Colour shows percentage change in daily number of journeys compared to the mean in the week 10th-16th March 2020 inclusive, by origin tiles that consistently reported data each day. Sufficient data were not available for tiles in the grey area. Note that (C) and (D) are weekend days and there was an increase in overall mobility on the 23rd March (see also Figure 2).

with mobility (as a percentage relative to the baseline) increasing at a rate of 0.15 percentage points per day. For the period since the 27th April this rate of increase has been 0.51 percentage points per day. We conclude that since the beginning of April there has been a gradual increase in the number of daily trips made per LAD and that this rate has increased recently.

There was a greater decrease in the median number of trips made within high-density populations compared with low-density populations (Figure 4), from 91% to 47% of the baseline in low-density populations, and 90% to 40% of the baseline in high-density populations between the 18th and the 26th of March. Prior to the beginning of lockdown on the 24th of

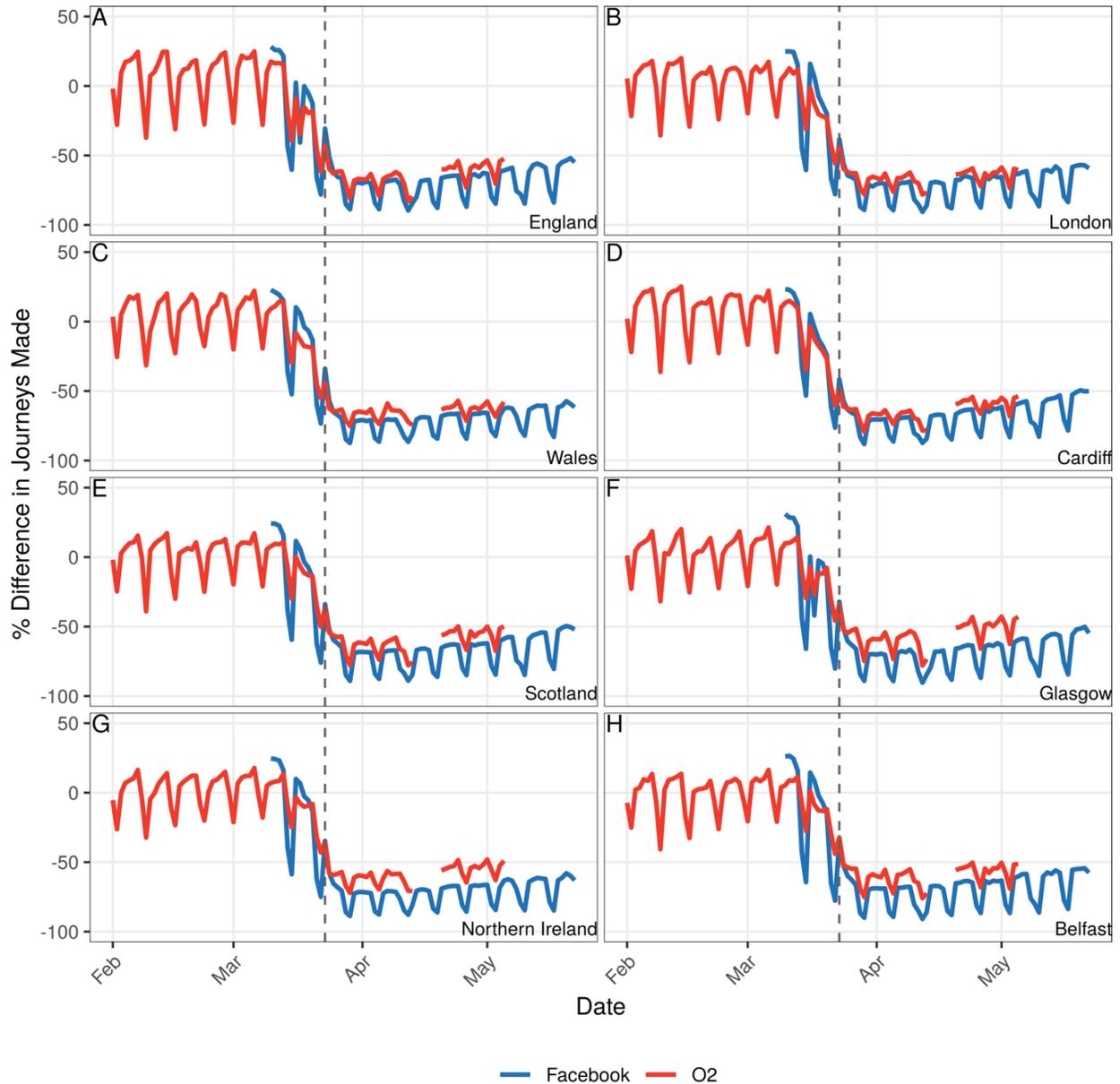


Figure 2. Consistent changes in mobility observed between Facebook data and mobile phone data. Change in movement over time as a percentage of baseline movement for the four home countries within the UK and their largest city for Facebook data (blue) and mobile phone data (red). Baseline movement defined as the mean number of journeys starting within a small unit within each city from 10th-16th March 2020 inclusive. The dashed vertical line at 23rd March indicates when the most stringent lockdown measures were imposed.

March, there was a higher median mobility, more pronounced weekend effects (greater decrease in mobility at the weekend than on weekdays), and a greater range in mobility within high-density populations compared with populations living in regions of lower population density. However, after the lockdown the reduction in mobility in high- and low-density populations was comparable on weekdays, and slightly higher on weekends in low-density populations (e.g. 43% and 38% of the baseline in low- and high-density populations respectively on the 31st of March 2020). Also, the range of reductions

in mobility in high-density populations was not symmetric about the median: some high-density populations reduced their levels of mobility by almost 100% compared to baseline levels, whereas the range in low-density population was narrower and approximately symmetric about the median pre and post-lockdown.

We observed similar changes in the distribution of journey distances (Figure 5) to those described above for the number of journeys. In the two lowest quartiles of population density

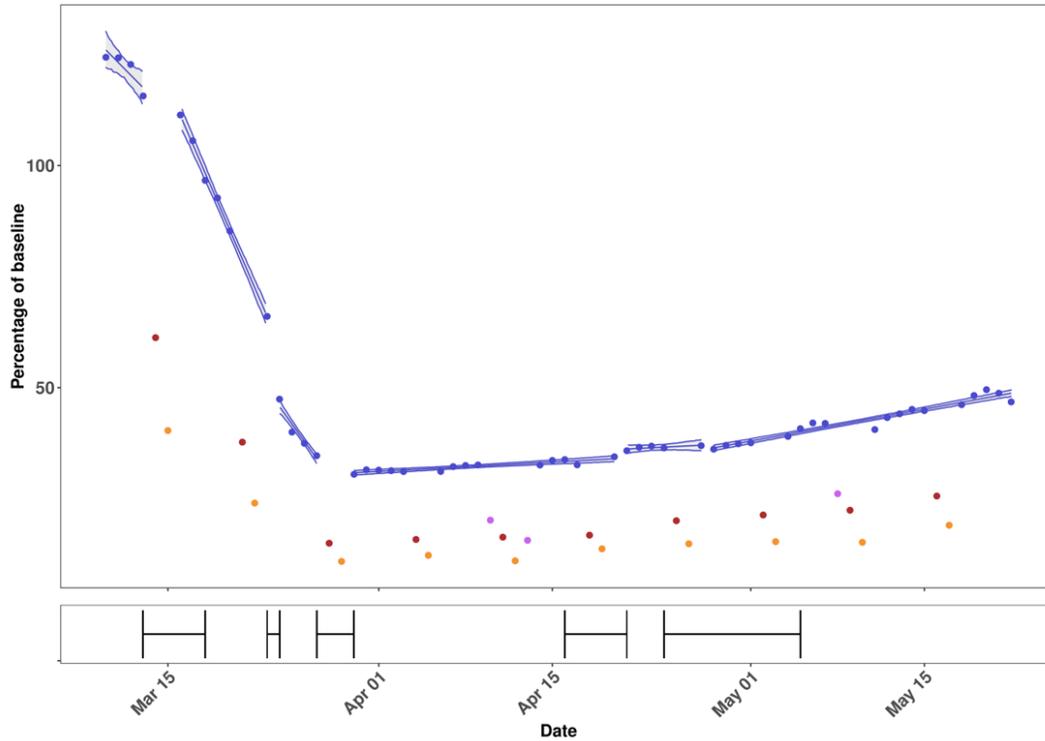


Figure 3. Fit of the segmented-linear model with 5 breakpoints to the percentage relative to baseline of number of trips against time (top panel). Weekdays (blue), Saturdays (red), Sundays (orange) and bank holidays (purple). Bottom panel shows univariate 95% confidence regions for each breakpoint.

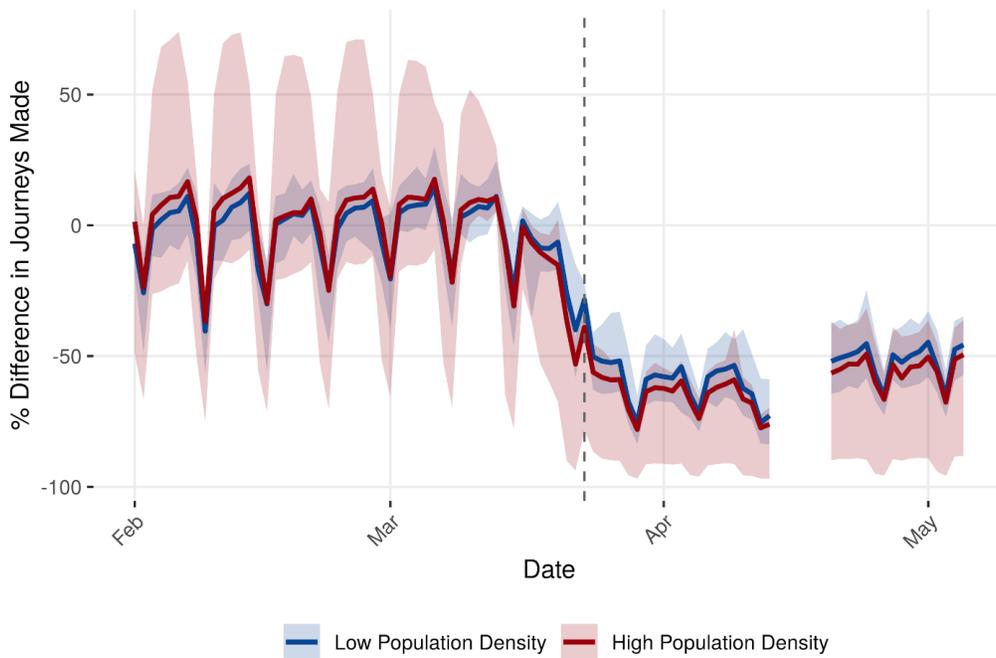


Figure 4. We ranked each UK local authority district by population density and determined the corresponding quartile for each local authority district, with lower population density in quartile 1 and higher population density in quartile 4. The shaded region is the range of percentage differences in journeys made at each time point for both lower quartile (low population density) and upper quartile (high population density) using the mobile data. Solid lines are the median difference from baseline within each quartile. The dashed line on 23rd March is when the most stringent lockdown measures were imposed.

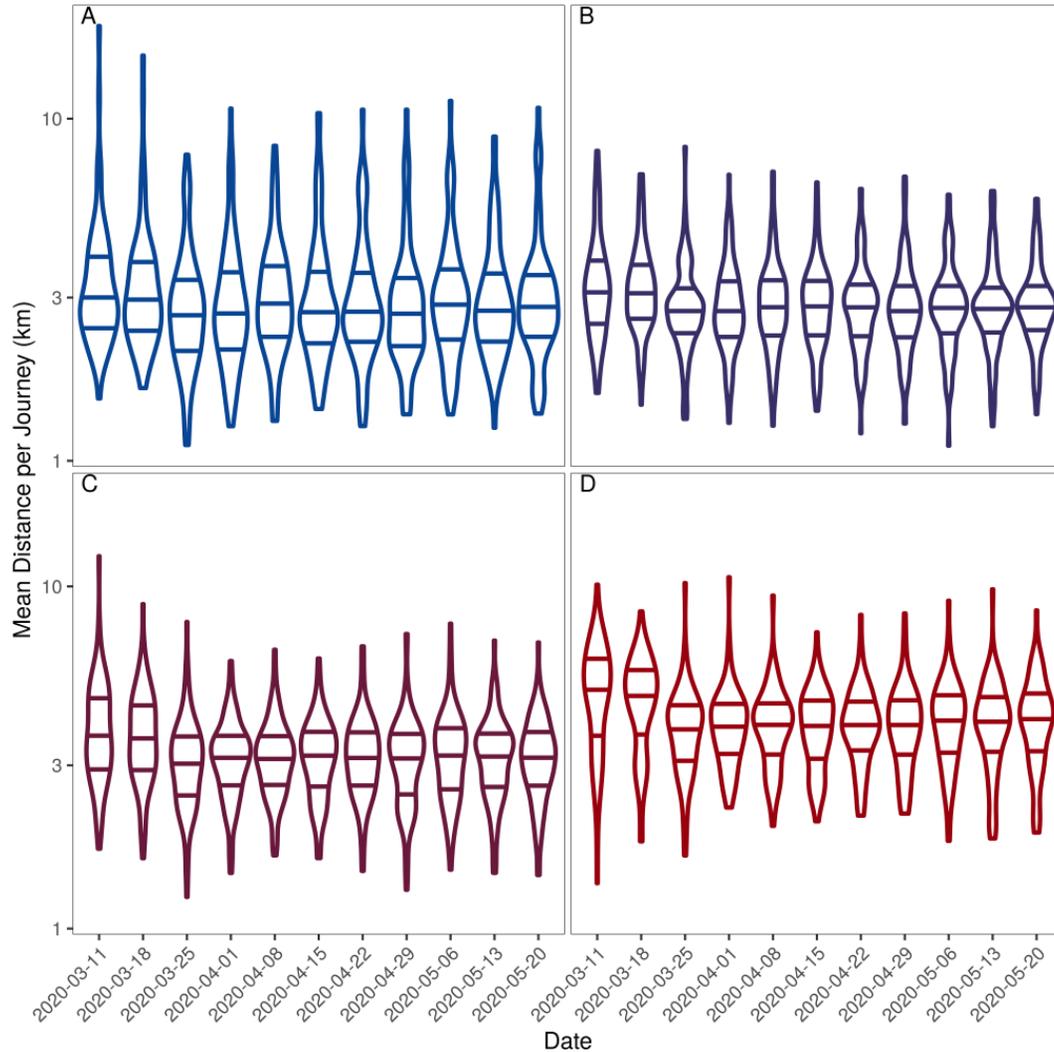


Figure 5. Distribution of mean journey lengths per LAD on each Wednesday in the Facebook data for areas of increasing population density. (A–D) Journey length distributions for each quartile of population density from lowest (A) to highest (D). The y axis is on a log₁₀ scale and the median and interquartile range for each distribution is shown by the horizontal lines. A Gaussian kernel is used to define the shape of the distributions which are truncated at the minimum and maximum point in the data.

(Figure 5A, B), the decrease after lockdown was less and the median journey distance was lower at all time points than in the most densely populated LADs. However, the range of journey distance was greater both before and after the lockdown in the lowest density populations (Figure 5A) than in high-density populations (Figure 5D).

Discussion

The sequence of policy decisions implemented up to and including the evening of the 23rd of March 2020 was successful in reducing mobility in the UK, measured as the number of journeys made each day, which may be a good proxy for non-household social interactions. According to both the

Facebook and mobile network data there does not appear to have been substantial variation in regional adherence to these interventions, nor was there a noticeable difference between adherence in low and high population density areas. It appears that mobility began to decrease around one week before the lockdown was enforced in the UK on the evening of 23rd of March, but that the sharpest drop was after that date. A gradual increase in the number of trips made each day started at the beginning of April and has continued since that time. This rate of increase may have accelerated somewhat, as indicated by our segmented linear model fits, but the currently estimated rate is that the population is recovering only ~0.5% of prior mobility levels per day.

Interestingly, the degree of synchrony observed in the UK response to lockdown described here has not always been observed elsewhere. For example, state-level mobility in the USA shows much greater variability¹⁵ as does between-borough movement in New York City¹⁶, whereas both Italy³ and Brazil⁴ have observed considerably more spatially consistent mobility trends during the course of the SARS-CoV-2 epidemic, similar to what we report here for the UK. This variation in mobility may have resulted in differences in the transmission of SARS-CoV-2 and therefore could explain some of the intra and international variation in cases and deaths related to SARS-CoV-2 infection^{3,4,15,16}.

However, there are slight differences in the median journey distance between high and low population density areas before and after the 23rd of March. This may be because people living in small towns and villages have less far to travel to reach their workplace and essential shops than people who live or work in cities. The greater decrease in median journey distance within densely populated areas during the lockdown possibly reflects the reduced number of people commuting in and out of the centre of major cities.

This study has some limitations. Firstly, data were only reported for locations with sufficiently high numbers of reporting handsets to ensure journeys were not identifiable. This resulted in a subset (approximately 90%) of UK LADs being included in our analyses. Secondly, it is difficult to assess how representative our data are of the wider population not using the Facebook app or O2 as a mobile phone provider. However, it is reassuring that the trends in mobility change are largely consistent between the two data sets. Thirdly, the data sets record handset movement in terms of the number of journeys made and the average distance travelled, which, if being considered as a proxy for transmission, may not always capture the true changes in social contact behaviour. However, we note that decreases in mobility were closely followed by a plateauing and then reduction in the daily case and death rate in the UK (<https://coronavirus.data.gov.uk/>). Finally, there is no obvious functional form with which to fit the pattern of recovery of mobility following the lockdown. Therefore, we used a segmented linear regression approach to identify potential breakpoints. During periods of gradual change, these breakpoints may not be reflective of actual step-changes in population behaviour.

We note that Facebook data, which uses GPS location, is collected at a finer spatial resolution compared with the mobile network data, which is at most location level. However, mobile network data include all types of mobile phones registered to the mobile network, not just smart phones with the Facebook app installed and geolocation services enabled, and is therefore likely to include a larger, and more representative, sample of the population. These differences may account for the difference in change in mobility between the two data sets seen in [Figure 2](#). Comparison with other mobility data sets such

as Google handset location data (<https://www.google.com/covid19/mobility/>) and Apple route finding data (<https://www.apple.com/covid19/mobility>) was beyond the scope of this project because neither of these data sets had sufficient coverage at the subnational level.

Here we have demonstrated the utility of mobile phone data for monitoring changes in human mobility, by assessing how it has changed in response to the COVID-19 epidemic in the UK. We see that whilst adherence to movement restrictions was initially high and geographically consistent, it is waning over time. It will be important to continue to monitor changes in mobility as the epidemic progresses, to inform policy towards limiting the spread of SARS-CoV-2.

Data availability

Underlying data

The raw data needed to replicate these analyses has not been made public by the data providers, meaning we are forbidden from sharing it with this paper. However, the reader can apply for access to the Facebook data through the Geoinsights platform here: <https://dataforgood.fb.com/>, or by emailing disastermaps@fb.com or diseaseprevmaps@fb.com. Details on how to access these data are available at <https://dataforgood.fb.com/tools/population-density-maps/>.

Mobile phone operator data was provided by O2 Motion. More details on how to apply to access these data can be found at <https://www.o2.co.uk/business/solutions/data-mobile/o2-motion>.

Extended data

Zenodo: [mrc-ide/covid-uk-mobility-report: Initial Release. https://doi.org/10.5281/zenodo.3865406](https://doi.org/10.5281/zenodo.3865406)⁹.

This project contains the following extended data:

- [wellcome_open_mobility_supp_mat.pdf](#) (supplementary material containing Tables S1 and S2, and Figures S1 and S2).
- Code used to perform the statistical analyses and produce [Figure 1–Figure 5](#), S1, and S2.

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

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[Reference Source](#)

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Andrew Schroeder

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The authors have demonstrated clearly and convincingly based upon two distinct sources of digital mobility data that populations throughout the UK responded to Covid-19 related social distancing orders by dramatically reducing rates of physical mobility relative to a baseline mobility level of early March, 2020. One data source is derived from the O2 mobile phone provider and the other is derived from aggregated users of the Facebook smart phone app with location services enabled on an opt-in basis.

The two data sources, O2 and Facebook, demonstrate remarkable consistency between them, and between geographic regions throughout the UK. The consistency of agreement between data sources, in terms of rates of mobility change relative to baseline and the timing of key changes in the rate of mobility, is highly significant with only very minor regional variations. The importance of this finding pertains to the issue of general representativeness of the data, one of the key issues in the use of digital mobility data for physical distancing measurement. Comparative research into digital mobility data, particularly in terms relative representativeness of the population sample, is still in early stages, with considerable variance globally. (See Kishore N, Kiang M, et al.: Measuring mobility to monitor travel and physical distancing interventions: a common framework for mobile phone data analysis. *The Lancet Digital Health*; Sept 01, 2020¹) The contribution of this article to the advancement of comparative digital mobility research is therefore substantial.

By showing that O2 and Facebook closely correlate on timing and magnitude of mobility changes the authors increase confidence in the digital mobility signal substantially, even though the causes of the variations they did detect are not explained sufficiently. Nevertheless, the regional correlation overall is strong enough to merit the author's conclusion that the UK responded to physical distancing orders with a high degree of unanimity throughout the country.

The one area which may require further inquiry relates to the causes of timing in mobility change. Whereas the authors note highly specific responses to the wording of distancing orders in March,

with variances measured in days, there is no similar attention paid to the clear erosion in rates of mobility reduction which occurred in April. This is curious given that the erosion is not only evident in both the O2 and the Facebook data, but also potentially significant in terms of epidemiological factors noted by the authors, including the viral contact rate. Likewise, the change in April occurred well before formal policy changes were enacted on 11 May, and bear further scrutiny to understand what may be important distinctions between short-term health policy responses and longer-term behavioral shifts.

References

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Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My area of expertise is focused on spatial analysis and applied digital informatics for humanitarian aid and public health.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 17 August 2020

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Rowland Kao 

Roslin Institute, University of Edinburgh, Edinburgh, UK

This is a useful paper, outlining changes in mobility across geographical regions of the UK. It also analyses these data with a simple model which can be used to break up changes in mobility patterns in a sensible and parsimonious way.

I only have a few comments to make about the paper.

1. The authors at one point mention Ireland but really only seem to analyse Northern Ireland, which is in the UK.
2. The paper combines data from O2 and Facebook - these of course cover different aspects of the data, and it is very good to know that despite this, there is quite good consistency in their temporal signatures. However there do appear to be some differences - it might be useful to point out how they are different (e.g. the Facebook data seem to show greater variation across days of the week and between the pre and post lockdown periods - is this correct, and if so, is there a known reason why
3. It is mentioned in the methods that the area of tiles is about 25km². If I remember correctly the tiles are determined by lat and long rather than a fixed distance and so will vary over the globe? if this is correct, it is probably worth stating.
4. I may have misunderstood the method but why are there gaps in the piecewise linear model as shown in figure 3?
5. A fair bit of the discussion hinges on the assumption that the mobility data 'may be a good proxy for non-household interactions.' and there there was no noticeable difference to adherence. I would challenge this as there is no real evidence that this is true. The restriction on what are fairly long distance movements is one thing. But adherence is a different thing altogether. I would argue that we really just don't know.
6. Related to this, the authors note that "we note that decreases in mobility were closely followed by a plateauing and then reduction in the daily case and death rate in the UK". This is true, but the mobility measures at the time were accompanied by social distancing measures. Given that these occurred at about the same time, its hard to say just how much mobility reduction had to do with this, as opposed to say the 2m rule, which was independent of it. A further suggestion that mobility may not have had a big effect on transmission directly, is that even though mobility as shown here was increasing steadily over the lockdown period, there does not seem to have been an equivalent increase in R. Of course other factors likely come into play there as well, but I would be cautious in linking the two. Of course, reduction in mobility has a big effect on geographical spread (or should) and this should probably be mentioned in the paper.
7. About the differences in median journeys between high and low density areas - I wonder if this may be partly due to different proportions of essential workers in the different areas - i.e. more people might still have to travel to work despite lockdown, rather than this simply being because of differences in commuting distance. You could see if this is the case by looking at the distribution of distance changes per journey. i.e. if a greater proportion of

journeys stayed consistent for example, this would suggest some people maintaining similar work patterns.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Infectious disease epidemiology, including impact of mobility patterns

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.
